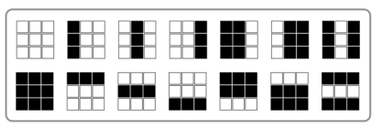
Restricted Boltzmann machine

Deadline: 30 Oct 23:59

Bonus

The goal of this exercise is to train a restricted Boltzmann machine to learn the bars-and-stripes data set.

To obtain credits for this exercise, upload a PDF-document presenting your results (details below). Use the upload button at the top of this page. Merge the PDF-files you have uploaded for Homework 3 into one document. Make a front page, and attach the computer code you have used in appendices. Submit your merged PDF-document to URKUND, before the deadline.



The 3×3 bars-and-stripes data set is shown in the Figure to the right, □ corresponds to -1, and ■ to +1. Train a restricted Boltzmann machine with 9 visible and different numbers of hidden neurons (all +/-1 neurons) using the CD-k algorithm for $k = 100$. Illustrate how the Kullback-Leibler divergence changes during training by plotting it as a function of the number of training steps, for $M = 2, 4, 8$ and 16 hidden neurons. Make sure that you use the correct algorithm for +/-1 neurons (lecture notes). To compute the Kullback-Leibler divergence, you need to approximate the model distribution. To this end, iterate the dynamics of the restricted Boltzmann machine and count the frequencies at which the different patterns occur. Determine for how long you must run the dynamics to get a precise estimate of the probabilities.

Illustrate how the model can complete patterns. After training with a suitable number of hidden neurons, feed only the first column of a pattern (set the visible neurons corresponding to the remaining columns equal to zero), iterate the McCulloch-Pitts dynamics, and plot the first ten patterns the model produces (Figure 4.6 in the Lecture notes). Discuss your results.

Presentation of results

Upload a one page PDF-document presenting and discussing your results.

Submit at most one A4 page with 12pt single-spaced text, and with 2cm margins. Each page may contain at most one Figure and/or one Table with the corresponding Figure and/or Table caption, in addition to the text discussing the results shown in the Figure/Table. It is not necessary to write a full page for each of the four problems in homework 3, but you must explain/describe what you have done and clearly state your answers/results to the questions, as well as your conclusions. When necessary you must discuss possible errors and inaccuracies in your results. Plots/graphs must have legible axis labels and tic labels. All symbols and lines must be explained in the Figure or in a caption. The Figure may consist of separate panels, label them 'a', 'b', and so forth).